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Mapping diffuse structures surrounding young clusters II: The case of NGC 3590

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Abstract. We utilize SOAR Spartan and SAMI imaging to caractherize the interstellar medium (ISM) surrounding NGC 3590: a 30 Myr old stellar cluster located in the Carina region. Comparative maps of the ISM emission in different bands allowed us to highlight unique features, such as shock fronts and gas excitation, and understand how ISM and clusters stars are interacting with each other.

Resumo. Nós utilizamos imageamentos Spartan e SAMI (SOAR) para caracterizar o meio interestelar (ISM) envolvendo NGC 3590: um aglomerado estelar jovem com cerca de 30 milhões de anos, localizado na região de Carina. Mapas comparativos da emissão do ISM em diferentes bandas nos permitiram destacar características peculiares, como frentes de choque e excitação do gás, e compreender como o ISM e as estrelas do aglomerado estão interagindo entre si.

Keywords. Stars: formation – ISM: general – open clusters and associations: general

1. Introduction

The interstellar medium (ISM) is a complex galactic component not completely understood yet. On the presence of newborn stars, the environment becomes even more complex and the stellar feedback effects are a crucial factor in the formation and evolution of these kinds of structures, such as dense cores, filaments and diffuse gas distribution.

Several studies about ISM have been made through narrow-band imaging and spectral analysis through SOAR/Spartan and SAMI facilities. For instance, the detailed morphology of the Crab Nebula was delineated by Loh et al. (2010, 2011), the study of H_2 emission morphology around ∼100 MYSOs by Navarete et al. (2014, 2015), and the reported discovery of HH 1165 by Riaz et al. (2017).

Aiming to contribute to the current understanding, we conducted a detailed study of the gas conditions surrounding the young stellar cluster NGC 3590 and the stellar feedback effects based on SOAR/SAMI and Spartan imaging, complemented by photometric data from Gaia, 2MASS, and AllWISE catalogs.

Our data covers ∼3'×3' fields (Fig. 1) observed with filters in 10 bands. We utilise the software StarFinder to extract the ISM emission and develop python scripts to produce the comparative maps. The software Aladin and StarFinder are used to perform the astrometric calibration, identify stellar sources and extract the background in the field observed through SAMI and Spartan. Aiming to characterise the stellar population, we established membership criteria by means of the Gaussian distributions in parallax and proper motion.

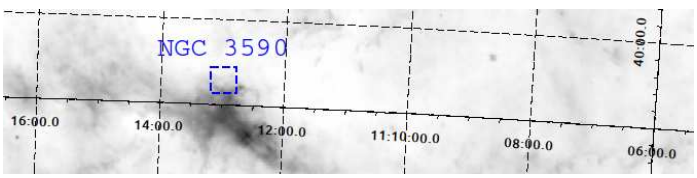

Figure 1. Observed field in the direction of NGC 3590. The map shows 12μm WISE band (W3). The molucular cloud H 1803 is noticed on the south.

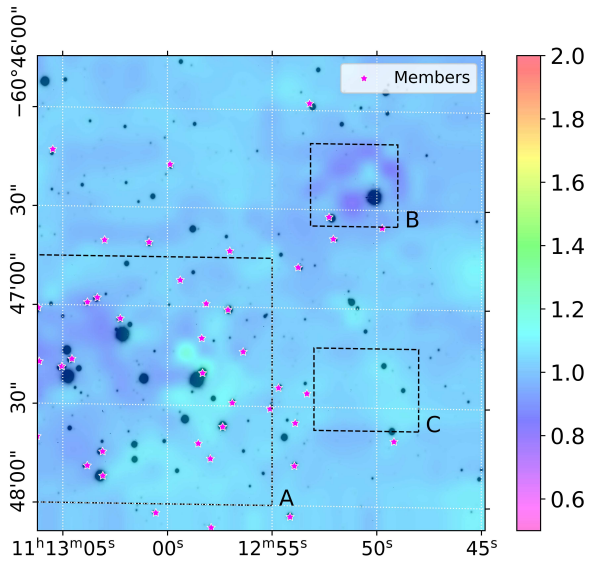

Figure 2. Map of the [S II]/[O III] ratio. Note the ratio < 1 in the massive stars' vicinities.

2. Results

We show here four comparative maps in same scale of colours, position and orientation. The normalisation for the emission in each band goes from 1 (minimum emission) to 2 (maximum emission), so that the fraction scales used on the comparative colour maps, obtained from the division between the images, range from 0.5 to 2.

The comparative maps show unique features with respect to the environment surrounding the massive stars (regions A and B), molecular clouds (southern region) and the peripheral region of the cluster.

The ratio [S II]/[O III] > 1 is frequently used as an indicative of excitation levels in the ISM. Figure 2 shows the excited gas is located on the peripheral regions of the cluster, away from the massive stars.

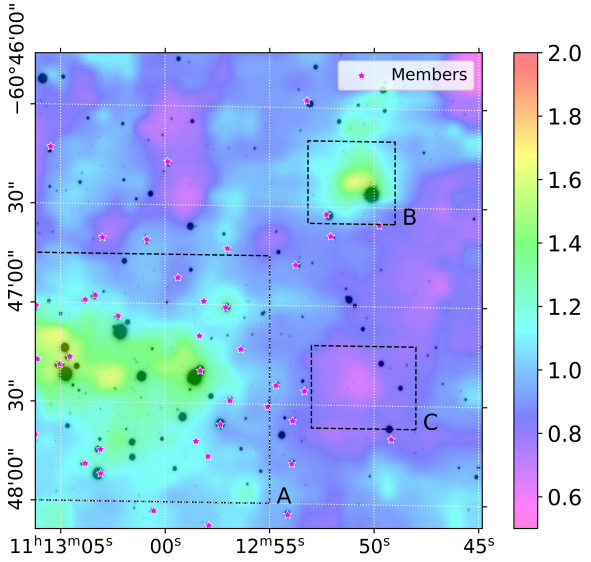

Figure 3. Map of the Hα/H_2 ratio. Overdensities (ratio > 1.6) are noticed in regions (A) and (B).

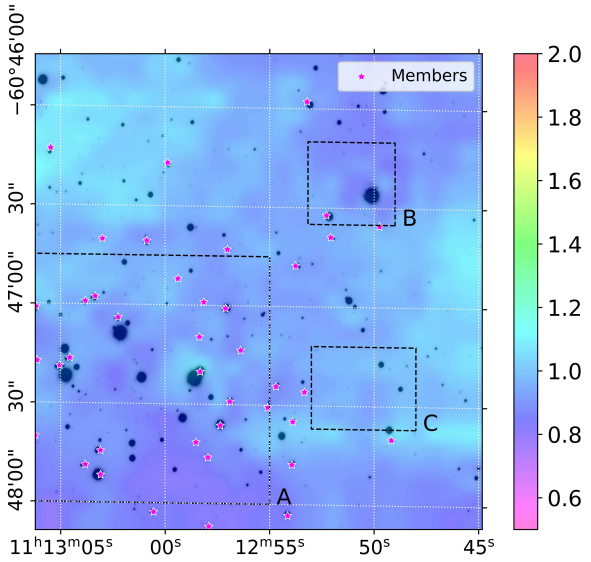

Figure 4. Map of the [S II]/Hα ratio emission.

The map of Hα/H_2 ratio, shown in Figure 3 highlights a concentration of neutral hydrogen when compared to the molecular hydrogen emission in regions A (cluster core and massive stars) and B (B-type star). It is also noticeable the existence of H_2 excess (ratio < 0.8) on the peripheral regions of the cluster – in region (C).

The presence of shock fronts surrounding massive stars are traced by high values of [S II]/Hα. Figure 4 shows some tenous features with [S II]/Hα > 1 around massive stars, as well as in the peripheral region.

The comparison between near-infrared and optical emission revealed a peculiar structure (C) without stellar counterpart. The structure is mostly prominat on the Figure 5. This structure is not visible through optical emission and/or colourmaps.

Beyond that, our preliminary analysis of punctual sources on the field has shown that NGC 3590 is located at 2.61 ± 0.03 kpc,

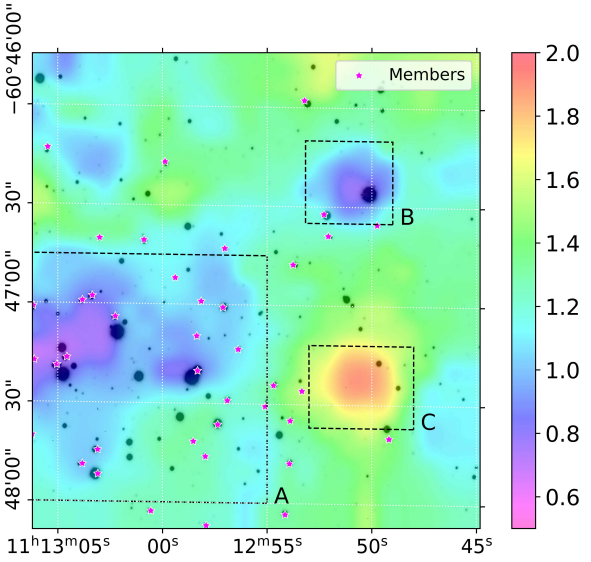

Figure 5. Map of the J/[O III] ratio emission. Note the conspicuous structure revealed on the region (C).

proper motion of the group is $(-6.12, 1.05) \pm 0.11$ mas/yr and PARSEC isochrones indicate the age is ~ 25 Myr old. We identified 17 massive stars being part of the group.

3. Conclusions

The comparative maps show the presence of diffuse regions that seem to delineate the cluster's structure of the core and its limits. The presence of a ring-like region surrounding 3 B-type stars is notable (B). We also highlight the presence of a gradient in the H 1803 cloud's direction. Beyond that, the infrared map reaveled the existence of a peculiar structure which does not seem to be associated to any visible star and is still under analysis.

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